Hydrodynamic study of the three-reactor chemical-looping process for hydrogen production

이도연, 서명원[1], 조원철[1], 김상돈*
KAIST; [1]한국에너지기술연구원
(kimsd@kaist.ac.kr*)

The three-reactor chemical-looping(TRCL) system for high purity hydrogen production and intrinsic CO2 separation is an innovative concept using a circulating oxygen carrier. The process employs iron oxide as an oxygen carrier, via which a redox reaction takes place alternately within three reactors, i.e. a fuel reactor(FR), where the natural gas is combusted to CO2 and H2O, a steam reactor(SR), where the steam is reduced to hydrogen, and an air reactor(AR), where the oxygen carrier returned to its original form by aeration. As it consists of three reactors and a riser, the TRCL system has complicated hydrodynamic characteristics. In this study, a cold mode TRCL system with non-mechanical valve was designed and constructed to investigate the solid circulation characteristics. A series of hydrodynamic tests on the system was performed in which zirconia was used as a bed material. The solid flow rate increased up to a maximum value with increasing gas velocity into the loop-seal. The gas leakages between AR and FR, and between FR and SR due to solid circulation were negligible. Furthermore, a 2D CFD simulation using a commercial CFD code was carried out in order to better understand the flow behavior of the gas solid mixture inside the TRCL system.